



Athabasca University 

SCHOOL OF COMPUTING & INFORMATION SYSTEMS

Adaptivity and Personalization in Learning Systems

Sabine Graf

School of Computing and Information Systems

Athabasca University, Canada

sabineg@athabascau.ca

<http://sgraf.athabascau.ca>

Adaptivity and Personalization in Learning Systems

How can we make learning systems more adaptive, intelligent and personalized



- Based on a comprehensive student model that combines learner information and context information
- In different settings such as desktop-based, mobile and ubiquitous settings
- In different situations such as for formal, informal and non-formal learning
- Supporting learners as well as teachers
- Develop approaches, add-ons and mechanisms that extend existing learning systems

Adaptivity and Personalization in Learning Systems

- Students' characteristics
 - Learning styles
 - Cognitive traits
 - Context information (environmental context & device functionalities)
 - Motivational aspects
 - Affective states
- Different settings
 - Learning management systems
 - Mobile / Ubiquitous learning

Adaptivity and Personalization in Learning Systems

- Students' characteristics
 - **Learning styles**
 - Cognitive traits
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 - Motivational aspects
 - Affective states
- Different settings
 - **Learning management systems**
 - Mobile / Ubiquitous learning

Adaptivity based on Learning Styles

- In order to provide adaptivity, two steps are required:
 - Identifying students' characteristics
 - Use the information about students' characteristics to provide them with adaptive courses
- Focus on extending learning management systems
 - Because these systems are typically used by educational institutions
- Focus on learning styles
 - Because it has high potential to support learners
 - Felder-Silverman learning style model

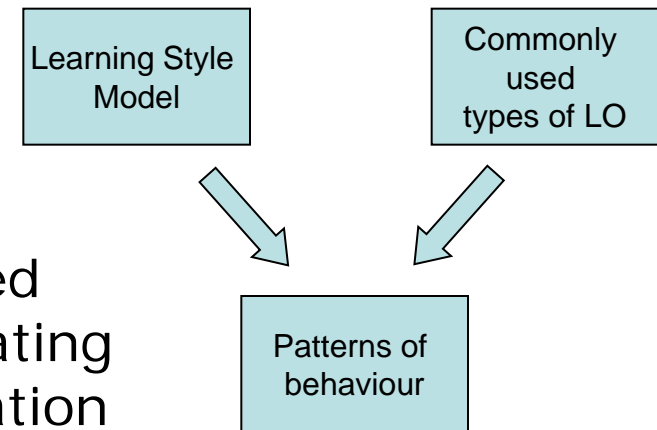
Automatic Identification of Learning Styles

Automatic Identification of Learning Styles

- Learning styles questionnaires have several disadvantages (e.g., students don't like them, non-intentional influences, can be done only once)
- Automatic modelling
 - What are students really doing in an online course?
 - Infer their learning styles from learners' behaviour
- Benefits of automatic student modelling
 - No additional effort for students
 - More accurate results
- General Goal
 - Developing an approach for learning systems in general
 - Implementing and evaluating this approach in Moodle
 - Developing a tool which can be used by teachers in order to identify students' learning styles

Automatic Identification of Learning Styles

- Identifying learning styles is based on patterns of behaviour
- Commonly used types of learning objects were used (Content objects, Outlines, Examples, Self-assessment tests, Exercises, Discussion forum) and relevant patterns were derived from these types of learning objects
- Overall, 27 patterns were used for the four learning style dimensions
- Calculation of learning styles is based on hints from patterns
- A simple rule-based mechanism is used for this calculation (currently investigating the use of neural networks in combination with particle swarm optimization)



Determining Relevant Behaviour

Active/Reflective	Sensing/Intuitive	Visual/Verbal	Sequential/Global
selfass_visit (+)	ques_detail (+)	forum_visit (-)	ques_detail (+)
exercise_visit (+)	ques_facts (+)	forum_stay (-)	ques_overview (-)
exercise_stay (+)	ques_concepts (-)	forum_post (-)	ques_interpret (-)
example_stay (-)	selfass_visit (+)	ques_graphics (+)	ques_develop (-)
content_visit (-)	selfass_result_duration (+)	ques_text (-)	outline_visit (-)
content_stay (-)	selfass_duration (+)	content_visit (-)	outline_stay (-)
outline_stay (-)	exercise_visit (+)		navigation_skip (-)
selfass_duration (-)	ques_rev_later (+)		overview_visit (-)
selfass_result_duration (-)	ques_develop (-)		overview_stay (-)
selfass_twice_wrong (+)	example_visit (+)		
forum_visit (-)	example_stay (+)		
forum_post (+)	content_visit (-)		
	content_stay (-)		

Evaluation

- Study with 75 students
 - Let them fill out the ILS questionnaire
 - Tracked their behaviour in an online course

- Using a measure of precision

$$\text{Precision} = \frac{\sum_{i=1}^n \text{Sim}(LS_{\text{predicted}}, LS_{\text{ILS}})}{n}$$

- Looking at the difference between results from ILS and automatic approach

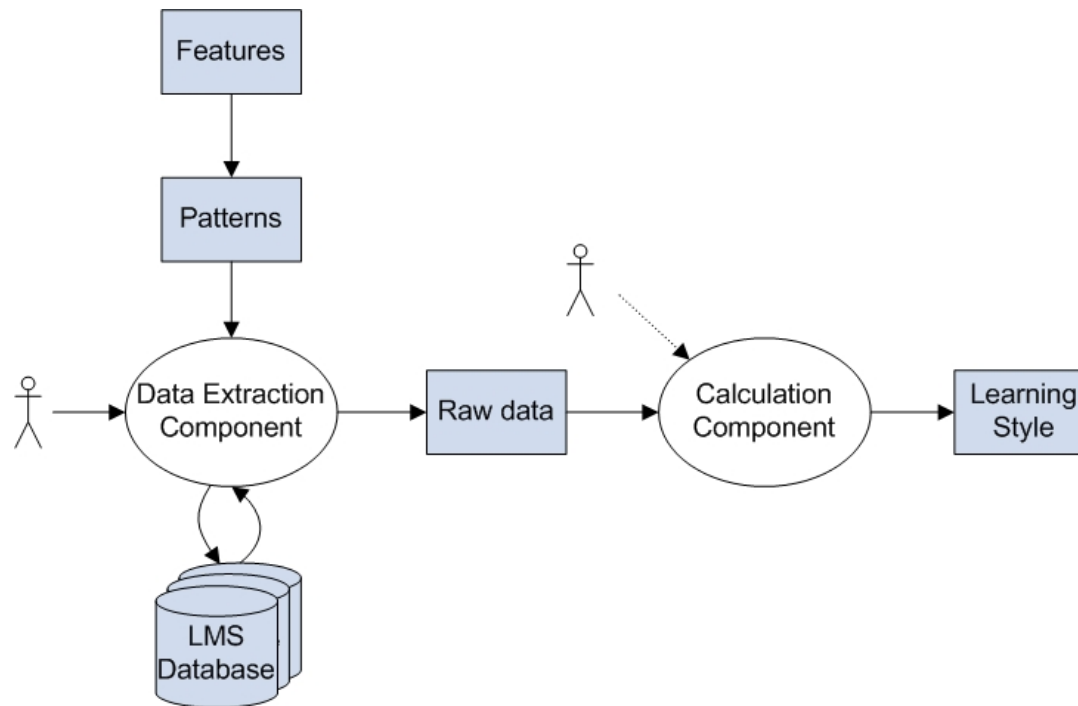
- Results

	act/ref	sen/int	vis/ver	seq/glo
comparison between ILS and automatic approach	79.33%	77.33%	76.67%	73.33%

→ suitable instrument for identifying learning styles

Tool for Identifying Learning Styles

- Developed a stand-alone tool for identifying learning styles in learning systems



Adaptive Mechanism for Providing Advanced Adaptivity based on Learning Styles

Adaptive Course Provision based on Learning Styles

- Develop a mechanism that enables learning systems to automatically generate adaptive courses
- General goals:
 - Mechanism should be applicable for different learning systems
 - Mechanism should ask teachers for as little as possible additional effort
- Benefits:
 - Teachers can continue using their courses in existing learning systems
 - Students get personalized support with respect to their learning styles

Adaptive Course Provision

- Incorporates only common types of learning objects
 - Content
 - Outlines
 - Conclusions
 - Examples
 - Self-assessment tests
 - Exercises

- Adaptation Features
 - Adaptive sequencing of examples, exercises, self-assessment tests, outlines and conclusions
 - Adapting the number of examples and exercises

- Teachers have to:
 - Provide learning objects
 - Annotate learning objects (distinguish between the objects)

Evaluation of the Concept

- Implemented add-on for Moodle
 - Evaluated with 437 students participating in a course about object-oriented modelling
 - Results show:
 - Matched Group: less time and equal grades
 - Mismatched Group: ask more often for additional learning objects
- Demonstrates positive effect of adaptivity

Extension of adaptive mechanism

Make adaptive mechanism more generic and easy to apply for different types of courses

- Added more types of learning objects (overall 12)
- Having as little restrictions as possible for teachers
 - Teachers can add many different types of learning objects (LOs) in their courses
 - Teachers can add types of LOs wherever they feel they fit (as they usually do in LMSs)
 - Teachers does not have to add types of LOs
 - However, the more LOs are available in the course, the more adaptivity can be provided
- Added adaptive annotations

Demo

Demo ...

Current/Future Work on Adaptivity based on Learning Styles

- Using **dynamic** student modelling for more accurate identification and frequent updates in adaptivity
- Developing a mechanism that analyses course content/activities and students' learning styles and then provides **recommendations to teachers**
- Providing adaptive courses in **mobile** environments

Considering Cognitive Abilities, Motivational Aspects and Context in Learning Systems

Considering Cognitive Abilities in Learning Management Systems

- Cognitive abilities are essential for learning and include, for example,
 - Working Memory Capacity
 - Inductive Reasoning Ability
 - Information Processing Speed
 - Associative Learning Skills
 - Etc.
- Automatic identification of cognitive abilities in learning systems
- Automatic provision of adaptive courses based on students' cognitive abilities (in combination with learning styles)

Motivational Aspects in LMSs

- Motivation is a key factor in education
 - Different learners are motivated differently
 - Our research aims at:
 - extending LMSs with motivational techniques which are domain-independent and course-independent
- Examples:
- Goal setting
 - Progress timeline & progress annotations
 - Ranking
 - Awards & award levels
 - ...
- Enable systems to identify preferred motivational techniques, in particular situations
 - Enable systems to provide personalized motivational techniques

Considering Learners' Environmental Context

- Due to the recent advances in mobile technologies, learners can learn anywhere
- Our research aims at:
 - Enabling mobile systems to know the learners' environment and provide him/her with learning objects/activities that work best in such environments
 - Investigating the use of different sensors (e.g., microphone, GPS, camera, etc.) to get a comprehensive context model, including, for example,
 - Whether a learner is in a silent or noisy environment
 - Whether a learner is alone or in a group
 - Whether a learner is at a particular place or moving (e.g., in a bus)
 - etc.
 - Provide learners with adaptive recommendations based on his/her context, considering individual and community-based data

Questions



Sabine Graf

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